BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Trip Report - Sterilizable Liquid Propulsion Briefing at Martin-Marietta Corp., Denver, Colorado, March 7, 1968 - Case 730

DATE: March 19, 1968

FROM: C. Bendersky
A. E. Marks

ABSTRACT

A final contract briefing on a "Sterilizable Liquid Propulsion System" was presented by the Martin-Marietta Corp. in Denver, Colorado on March 7, 1968. The contract, funded by JPL, was to demonstrate the feasibility of designing a self-contained liquid bi-propellant propulsion system and exposing this system to the sterilization cycle. The results of materials testing, component testing, and the full system tests are discussed within.

(NASA-CR-95446) STERILIZABLE LIQUID PROPULSION BRIEFING AT MARTIN-MARIETTA CORP., DENVER, COLORADO, 7 MARCH 1968 (Bellcomm, Inc.) 7 p

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MEMORANDUM FOR FILE

DISCUSSION

The writers attended the final briefing of a "Sterilizable Liquid Propulsion System" (JPL 951707) by the Martin-Marietta Corp. at Denver, Colorado on March 7, 1968. The objective of the experimental contract was to demonstrate the feasibility of heat sterilizing a fully loaded liquid propulsion module (LPM) intended for planetary landings.

The sterilization cycle consisted of six 29-hour cycles of ethylene oxide (ETO) decontamination at 122°F and 50% relative humidity. This was followed by six 76-hour cycles of dry heat sterilization at 275°F. The engine firing was conducted at room temperature. The contract included (a) a compatibility test program, (b) evaluation of flight-type components, (c) a build-up of a flight-type LPM around a 100 lbs. thrust Marquardt engine and (d) a sea level firing of 280 seconds duration.

A schematic of the LPM is shown in Figure 1 while Figure 2 shows a photo of the module. The LPM used nitrogen tetroxide/monomethyl hydrazine (NTO/MMH) propellants stored in spherical propellant tanks. High pressure gaseous nitrogen was used for propellant expulsion--the NTO tank using a positive displacement diaphragm and the MMH tank a surface tension screen. The program was culminated with a successful firing in a one "g" (positive) field with all components operating satisfactorily.

The significant results of the program can be divided into three areas:

(1) compatibility of materials with propellants,

(2) compatibility of propellants with materials, and

(3) component and full module testing.

MATERIALS COMPATIBILITY

1. Titanium and titanium alloy 6 Al-4V were the only metals compatible with both propellants. Almost all materials were compatible with MMH.

2. Stainless steels are completely unacceptable for use with NTO.

3. Teflon TFE and FEP were the only non-metals compatible with both propellants.

PROPELLANTS COMPATIBILITY

1. NTO is highly reactive and when exposed to an incompatible material will cause the formation of solid products which will impair component functions.

2. NTO is chemically stable at 275°F showing no tendency to decompose.

3. The use of Apollo spec. green NTO (0.4% minimum NO) is necessary to insure that stress cracking of titanium does not occur.

4. MMH is relatively stable at 275°F with only a small amount of decomposition slowly taking place. The propellant still remained within military specification requirements.

COMPONENT AND FULL MODULE TESTING

1. All components degraded somewhat during sterilization except the thrust chamber valves. Adequate fixes were found, however, to allow full module build-up and testing.

2. The module was successfully fired. The corrected altitude thrust was 109 lbs compared with the target of 100 lbs. The delivered specific impulse was 294 sec, the nominal for a non-sterilized chamber.

3. Maximum tank pressures during the sterilization process were 800 psia in the NTO tank and 80 psia in the MMH tank.

CONCLUSIONS

Based on these experimental results, it would seem that the sterilization cycle imposes severe design and fabrication restraints on LPM's. Private conversations with Dr. D. Dipprey of JPL revealed that some serious thought is being made to reduce the severity of the requirements.

A significant fact to be noted about this study, however, was the approach taken--that of building a self-contained flight-type LPM to withstand the sterilization cycle. The implication of this design philosophy is that the propulsion stage and hence the planetary probes must pay the large tank weight penalty because of the high tank pressures occurring during the sterilization cycle.

An alternate sterilization scheme would be the sterilization of the propellants in a heavyweight tank followed by the transfer of sterilized propellants to the stage which is simultaneously sterilized dry. With this technique, the sterilization weight penalty is left on the ground. Planetary probes can then be designed witn high mass fractions and significantly better performance.

PROPULSION RESEARCH BRIEFING

In addition to the sterilization study, a propulsion research briefing by Martin was presented on:

1. Summary of zero-g work - drop tower experiments;
2. Summary of a "Vent Free Fluorine Propulsion System", LH_2/LF_2 experimental contract (confidential);
3. Status of the monopropellant hydrazine transtage attitude control system development;
4. Summary of engine plume studies for impingement interactions in space.

A copy of the charts and other descriptive material is available from the writers (Martin Document DE-22-15-14).

C. Bendersky

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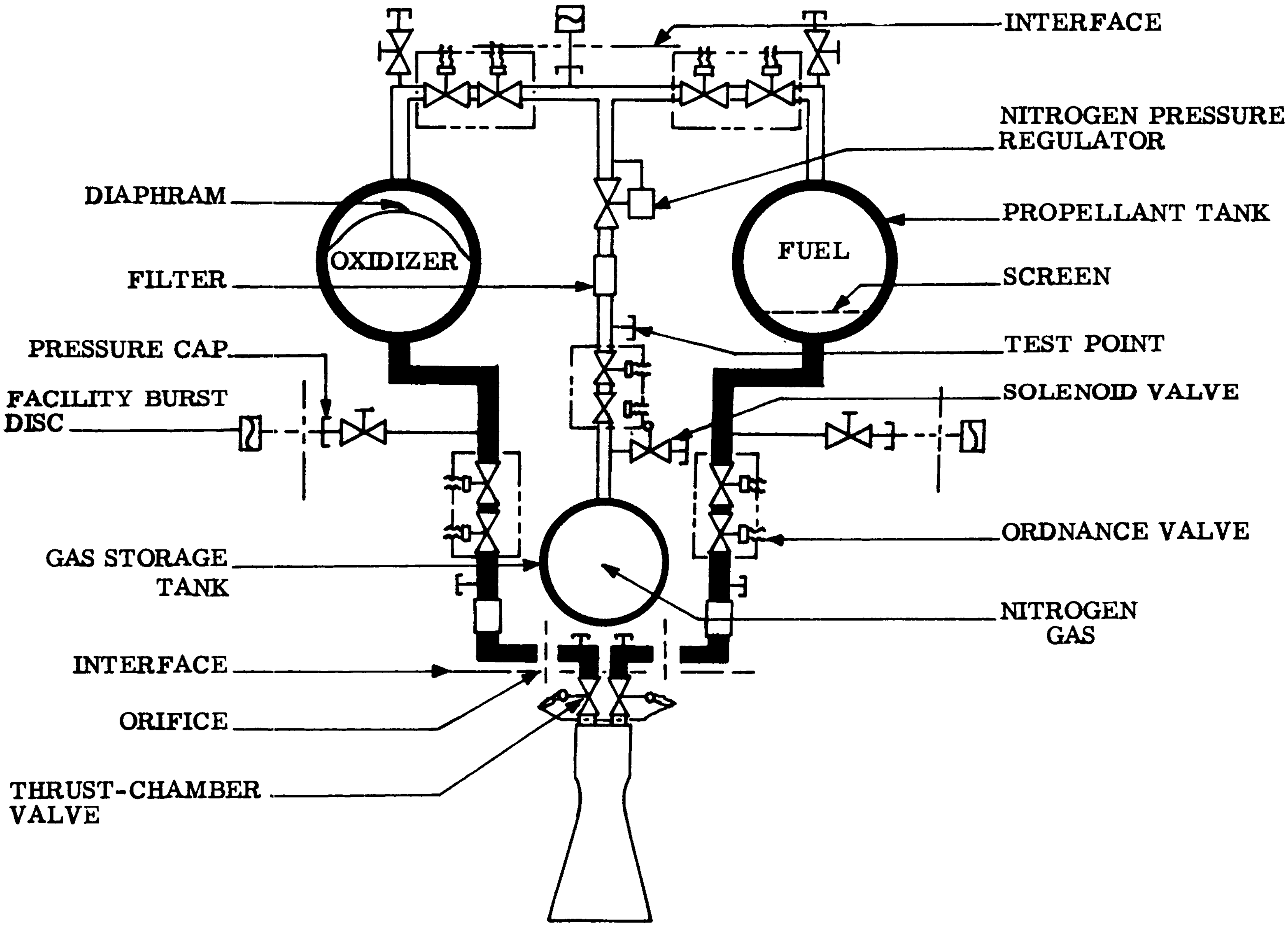
Attachments

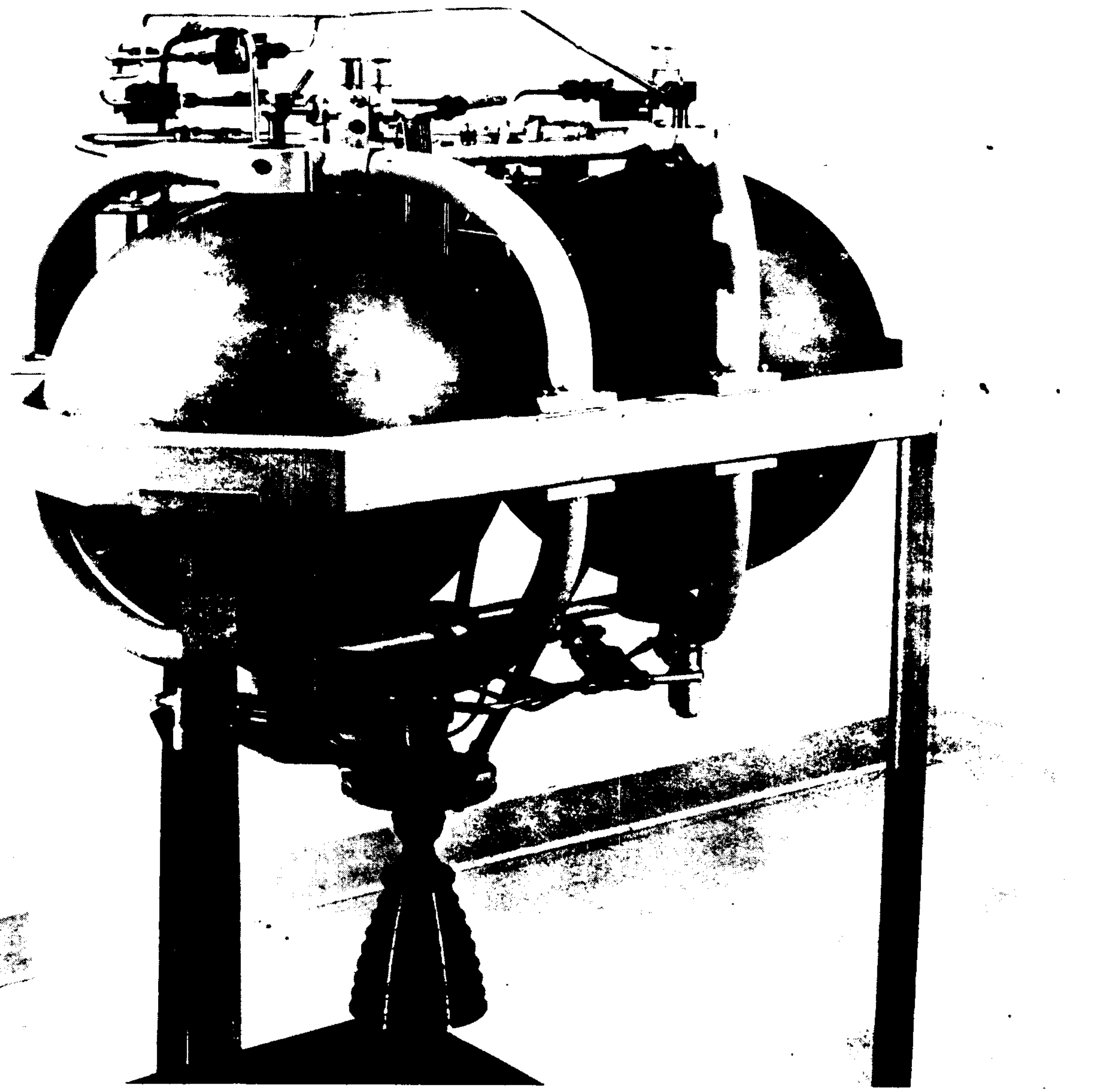
SYSTEM SCHEMATIC

MARTIN MARIETTA



MODULE ASSEMBLY

MARTIN MARIETTA



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From: C. Bendersky
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